Missouri Department of Natural Resources
Water Protection Program

Total Maximum Daily Load (TMDL)

for

Lateral #2 Main Ditch
Stoddard County, Missouri

Completed: October 30, 2008
Approved: December 10, 2008

Total Maximum Daily Load (TMDL)
Lateral #2 Main Ditch
Pollutant: Sediment

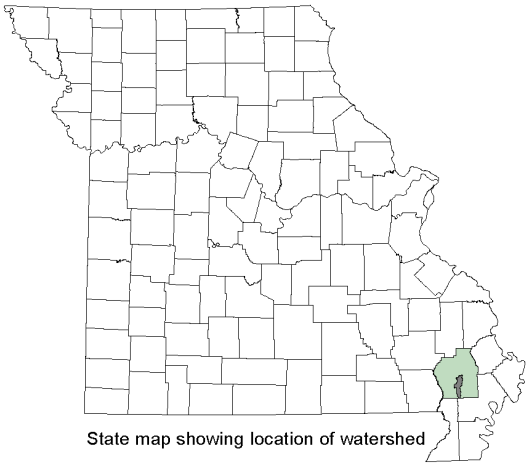
Name: Lateral #2 Main Ditch

Downstream Location: Near Dexter in Stoddard County

Hydrologic Unit Code (HUC): 08020204-040001

Water Body Identification (WBID): 3105[1]

Missouri Stream Class: Class P[2]


State map showing location of watershed

Beneficial Uses[3]:

- Livestock and Wildlife Watering.
- Protection of Warm Water Aquatic Life.
- Protection of Human Health (Fish Consumption).
- Whole Body Contact Recreation - Category B.

Size of Impaired Segment: 11.5 miles

Location of Impaired Segment: From Section 24, T23N, R10E (downstream) to Section 25, T25N, R10E (upstream)

Pollutant: Sediment

Pollutant Source: Agricultural Nonpoint Source

TMDL Priority Ranking: Medium

1. Introduction

This Lateral #2 Main Ditch Total Maximum Daily Load (TMDL) for sediment is being established in accordance with Section 303(d) of the Clean Water Act. This water quality limited segment of Lateral #2 Main Ditch in Stoddard County is included on the EPA approved 1998 and 2002 303(d) lists for Missouri. Much of this TMDL was developed by EPA in 2006 to meet the requirements of the 2001 Consent Decree, *American Canoe Association, et al. v. EPA*[4]. However, there was no actual data from Lateral #2 Main Ditch to complete the Load Duration Curve (Figure

[1] Mistakenly listed as WBID 3106 on the 1998 303(d) List
[2] Class P streams maintain permanent flow during drought conditions. See 10 CSR 20-7.031(1)(F)
[3] For Beneficial Uses see 10 CSR 20-7.031(1)(C) and Table H
[4] No. 98-1195-CV-W in consolidation with No. 98-4282-CV-W, February 27, 2001.

2). Therefore, the Missouri Department of Natural Resources (the department) collected the necessary data in the summer of 2007. The department completed this TMDL following the EPA format and using the graphs, flow and TMDL curve as calculated by EPA.

The purpose of a TMDL is to determine the pollutant loading a water body can assimilate without exceeding the water quality standard (WQS) for that pollutant. The TMDL also establishes the pollutant load allocation necessary to meet the WQS established for each water body based on the relationship between pollutant sources and in-stream water quality conditions. The TMDL consists of a wasteload allocation (WLA), a load allocation (LA) and margin of safety (MOS). The WLA is the fraction of the total pollutant load apportioned to point sources. The LA is the fraction of the total pollutant load apportioned to nonpoint sources. The MOS is a percentage of the TMDL that accounts for the uncertainty associated with the model assumption and data inadequacies.

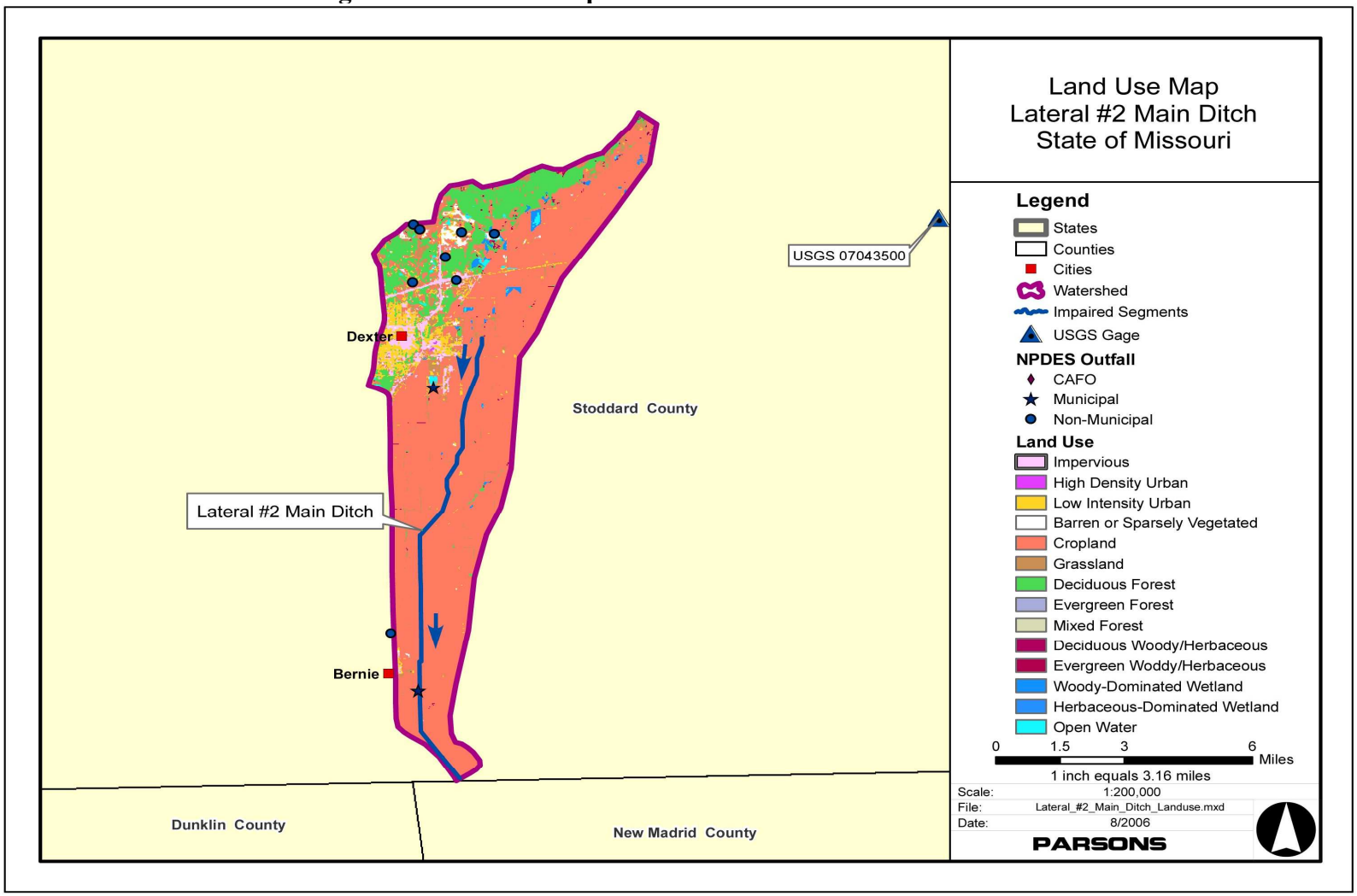
2. Background and Water Quality Problems

Lateral #2 Main Ditch is located in the Little River Ditches River Basin in Stoddard County. It flows southward, past Dexter and Bernie. Eleven and one half miles of Lateral #2 Main Ditch is listed as impaired for sediment due to agricultural nonpoint source runoff. The associated watershed is approximately 44 square miles with predominant land uses of cropland, deciduous forest, and low intensity urban (Table 1 and Figure 1).

Table 1: Land Use Distribution for Lateral #2 Main Ditch

Type	Percent
Barren or Sparsely Vegetated	0.99%
Cropland	74.70%
Deciduous Forest	11.99%
Deciduous Woody/Herbaceous	0.36%
Grassland	3.52%
Herbaceous-Dominated Wetland	0.05%
High Density Urban	0.02%
Impervious	2.56%
Low Intensity Urban	4.40%
Open Water	0.56%
Woody-Dominated Wetland	0.84%
Watershed Area = 44.04 mi²	**Sum: 100.00%**

Figure 1: Land Use Map for Lateral #2 Main Ditch Watershed



A combination of natural geology and land use in the Mississippi embayment portions of the state (where Lateral #2 Main Ditch is located) is believed to have reduced the amount and impaired the quality of habitat for aquatic life. The major problems are excessive rates of sediment deposition due to stream bank erosion and sheet erosion from agricultural lands, loss of stream length and loss of stream channel heterogeneity due to channelization, and changes in basin hydrology that have increased flood flows and prolonged low flow conditions. Loss of tree cover in riparian zones has caused elevated water temperatures in summer and a reduction in woody debris, a critical aquatic habitat component in Mississippi embayment streams. The most compelling evidence of loss or impairment of aquatic habitat is the historical changes in the distribution of fish in Missouri. Many species of fish no longer appear in portions of the state where they once lived (MDNR, 2005). All waters of the state, as per WQS, must provide a suitable home for aquatic life. The conditions include both the physical habitat and the quality of the water. TMDLs are not written to address habitat, but are written to correct water quality conditions. The water quality condition addressed in Lateral #2 Main Ditch is sedimentation.

Lateral #2 Main Ditch was placed on the Missouri 303(d) List for sedimentation primarily based on best professional judgment because little sediment data exists to directly document sediment impacts to the stream. General fisheries data and the effect of sediment on fish were the initial data used to consider Lateral #2 Main Ditch for 303(d) listing. Since the 303(d) listing, the department has developed a sediment protocol to determine if sediment is actually the pollutant in the streams listed and to arrive at a standard way to measure sediment. The first step of that protocol is a biological assessment to see if the biological community is actually impaired. However, a biological assessment is not yet available for this water body. For this TMDL, sediment targets were derived using generalized information from the ecological drainage unit (EDU).

3. Description of Sources

3.1 Point Sources

Twenty-one facilities in Stoddard County, located within the watershed, have permits through the state permitting system[5] (Table 2). One permit listed is a temporary permit issued during construction to control runoff of disturbed lands. Six permits are site specific and six are general permits. The other nine permits are for a variety of activities that do not contribute to the sediment impairment. Only the six site specific permits are allowed to discharge to the stream.

Table 2: Facilities with State Operating Permits

Facility	Permit number	County	Design Flow (MGD)[6]
Dexter, East Lagoon	MO-0023213	Stoddard	1.12
Bernie Municipal WWTF*	MO-0048054	Stoddard	0.35
Vaughn's Gaslight Village	MO-0048895	Stoddard	0.008

[5] The state permitting system is Missouri's program for administering the National Pollution Discharge Elimination System (NPDES) program.
[6] MGD = Million Gallons Per Day

Table 2 (cont.): Facilities with State Operating Permits

Facility	Permit number	County	Design Flow (MGD)[7]
Lemons Landfill West	MO-0106895	Stoddard	Varies
Lemons Landfill East (Outfall 01 and 02)	MO-0113891	Stoddard	4.2 and 8.9
Tyson Foods Inc. Dexter Plant	MO-0129798	Stoddard	0.0995
MFA Bulk Plant-Bernie	MO-G350138	Stoddard	Non discharging
Bootheel Petroleum Company	MO-G350192	Stoddard	Non discharging
Southeast Coop Service Co.	MO-G350210	Stoddard	Non discharging
Delta Asphalt-Dexter Plant	MO-G490640	Stoddard	Non discharging
Brown Sand & Gravel	MO-G500004	Stoddard	Non discharging
Delta Asphalt Inc, Dexter	MO-G500019	Stoddard	Non discharging
Doane Pet Care Co.	MO-R12A010	Stoddard	N/A
Tyson Foods Feedmill	MO-R12A084	Stoddard	N/A
Holden Pallet Co. Inc.	MO-R22A165	Stoddard	N/A
Ames True Temper Inc.	MO-R22C033	Stoddard	N/A
MFA Agri Service – North Site	MO-R240165	Stoddard	N/A
Ag Distributors - Dexter	MO-R240254	Stoddard	N/A
Southeast Coop Service Co.	MO-R240259	Stoddard	N/A
MFA-Agri Service – South Site	MO-R240430	Stoddard	N/A
Bernie Farmers Fertilizer	MO-R240483	Stoddard	N/A

*WWTF = Wastewater Treatment Facility

3.2 Nonpoint Sources

As noted earlier, most of the watershed is cropland (74.70 percent), deciduous forest (11.99 percent), or low intensity urban (4.40 percent). The cropland in the watershed appears to be concentrated near the main stem. Cropland that is adjacent to and drains into Lateral #2 Main Ditch could contribute to the sediment impairment. Although there are no state-permitted Concentrated Animal Feeding Operations (CAFO) in the watershed, there are other livestock that could contribute to sediment loading (Table 3). Overland runoff during rain events can easily carry sediment from feed lots and cropland into the stream. Anywhere there is exposed land, soil will erode into the creek, increasing the turbidity and concentration of total suspended solids (TSS) and decreasing the transparency. A certain amount of sediment enters streams naturally due to normal fluvial (flowing rivers and streams) processes. This is considered the background levels of TSS. However, human impact on the land has greatly increased erosion, making sedimentation the number one pollutant in the country. Sediment loading in Lateral #2 Main Ditch comes predominantly from nonpoint sources.

[7] MGD = Million Gallons Per Day

Table 3: Livestock Estimates per County[8]

	Stoddard
Cattle	
Beef	6,300
Milk	107
Cow/Calf	16,599
Hogs/Pigs	220
Sheep/Lambs	340
Poultry	
Layers	(D)
Broilers	1,728,606
Turkeys	(D)
Horses/Ponies	592

(D) Withheld to avoid disclosing data for individual farms.

4. Description of the Applicable WQS and Water Quality Targets

4.1 Beneficial Uses

Lateral #2 Main Ditch (WBID 3105) has the following beneficial uses:

- Livestock and Wildlife Watering.
- Protection of Warm Water Aquatic Life.
- Protection of Human Health (Fish Consumption).
- Whole Body Contact Recreation - Category B.

The stream classifications and designated uses may be found at 10 CSR20-7.031(1)(C) and (F) and Table H.

Use that is impaired:

- Protection of Warm Water Aquatic Life.

4.2 Antidegradation Rules

Missouri's WQS include the U.S. Environmental Protection Agency (EPA) "three-tiered" approach to anti-degradation, and may be found at 10 CSR 20-7.031(2).

Tier 1 – Protects existing uses and provides the absolute floor of water quality for all waters of the United States. Existing in-stream water uses are those uses that were attained on or after Nov. 28, 1975, the date of EPA's first WQS Regulation, or uses for which existing water quality is suitable unless prevented by physical factors such as substrate or flow.

[8] USDA- NASS Quick Stats (Livestock) 2002 Census of Agriculture, Volume 1 Chapter 2: Missouri County Level Data http://www.nass.usda.gov/census/census02/volume1/mo/st29_2_001_001.pdf

Tier 2 – Protects the level of water quality necessary to support the propagation of fish, shellfish, and wildlife and recreation in and on the water in waters that are currently of higher quality than required to support these uses. Before water quality in Tier 2 waters can be lowered, there must be an anti-degradation review consisting of: (1) a finding that it is necessary to accommodate important economical or social development in the area where the waters are located; (2) full satisfaction of all intergovernmental coordination and public participation provisions; and (3) assurance that the highest statutory and regulatory requirements for point sources and best management practices for nonpoint sources are achieved. Furthermore, water quality may not be lowered to less than the level necessary to fully protect the "fishable/swimmable" uses and other existing uses.

Tier 3 – Protects the quality of outstanding national resources, such as waters of national and state parks, wildlife refuges and waters of exceptional recreational or ecological significance. There may be no degradation of the quality of these waters (with the exception of some limited activities that result in temporary and short-term changes in water quality).

4.3 Narrative Criteria

The impairment of this water body is based on exceedence of the general, or narrative, criteria contained in Missouri's WQS, 10 CSR 20-7.031(3)(A), (C) and (G).

(A) Waters shall be free from substances in sufficient amounts to cause the formation of putrescent, unsightly or harmful bottom deposits or prevent full maintenance of beneficial uses.

(C) Waters shall be free from substances in sufficient amounts to cause unsightly color or turbidity, offensive odor or prevent full maintenance of beneficial uses.

(G) Waters shall be free from physical, chemical or hydrologic changes that would impair the natural biological community.

When the WQS is expressed as a narrative value, a measurable indicator of the pollutant may be selected to express the narrative as a numeric value. There are many quantitative indicators of sediment, such as TSS, turbidity and bedload sediment, which are appropriate to describe sediment in rivers and streams.[9] TSS was selected as the numeric target for this TMDL because it enables the use of the highest quality data available and is included in permit requirements and monitoring data.

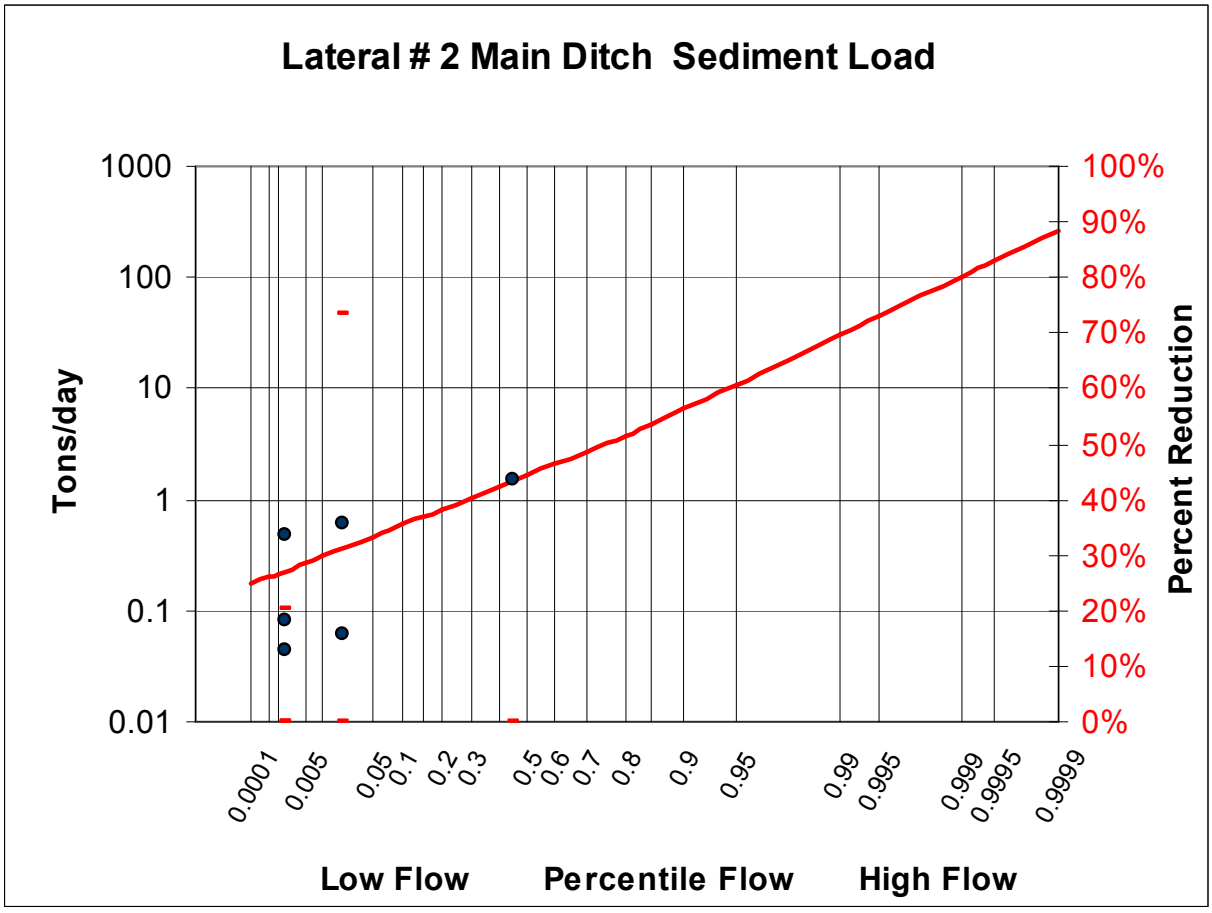
5. Calculation of Load Capacity

Load capacity (LC) is defined as the maximum pollutant load that a water body can assimilate and still attain WQS. This total load is then divided among a Wasteload Allocation (WLA) for point sources, a Load Allocation (LA) for nonpoint sources and a Margin of Safety (MOS). The LC for this TMDL has been defined as a load duration curve (LDC) over the range of flows for Lateral #2 Main Ditch, see Figure 2, where the solid red curve is the TMDL. Measurements are shown in Figure 2, where the round (black) points are loads calculated from TSS

[9] Framework for Developing Suspended and Bedded Sediments (SABS) Water Quality Criteria, U.S. Environmental Protection Agency, EPA-822-R-06-001, May 2006.

concentrations in Lateral #2 Main Ditch and the corresponding horizontal (red) bars are the percent reduction needed to meet the TMDL. For example, a 20.4 percent reduction is required to meet the TMDL loading capacity between the 1st and 5th percentile flows.

Figure 2: TMDL Curve over the Range of Flows



5.1 Modeling Approaches

In the case of Lateral #2 Main Ditch, where narrative standards are targeted for the impaired segment, a reference approach is used. For a full description of the development of suspended sediment targets using reference load duration curves (LDC) refer to Appendix B. In this approach, the target for pollutant loading is the 25th percentile of the current ecological drainage unit (EDU) condition calculated from all data available within the EDU in which the water body is located. Therefore, the 25th percentile is targeted as the TMDL LDC. Table 4 translates percentile of flow to segment flow for Lateral #2 Main Ditch in cubic feet per second.

Table 4. Estimated flow for range of percentiles at the impaired segment outlet.

	Percentile of Flow	Discharge (cubic feet per second)
Flow Estimate for Lateral #2 Main Ditch Based on Drainage Area and Synthetic Ecological Drainage Unit Flow	0.1	6.39
	0.3	11.3
	0.5	17.6
	0.7	28.8
	0.9	63.8

6. Waste Load Allocation (Point Source Loads)

Waste Load Allocation (WLA) is the allowable amount of the pollutant that can be assigned to point sources. The WLA is set to the lesser of current permit limits or technology based effluent limits (TBELs). TBELs are defined in a permit based on facility type. Mechanical wastewater treatment facility (WWTF) permit limits are a weekly average TSS concentration of 45 mg/L and a monthly average TSS concentration of 30 mg/L (or 45/30). Equivalent to Secondary WWTF permit limits are a weekly average TSS concentration of 60 mg/L and a monthly average TSS concentration of 45 mg/L. Wastewater treatment lagoon permit limits are TSS concentrations of 120 mg/L average weekly and 80 mg/L average monthly, respectively. Additionally, permits can be written to target lower limits if the specific facility is capable of performance exceeding TBELs.

Stoddard County has two municipal WWTFs, one domestic WWTF, and three non-municipal facilities discharging to tributaries of Lateral #2 Main Ditch. Table 5 lists these permitted site-specific point source discharges and WLAs based on their current permit limits and permitted design flows. Based on the assessment of sources, point sources discharging municipal or domestic wastewater do not significantly contribute to the water quality impairment relative to sediment impacts on stream biology. Therefore, no net reduction in current permit limits is required for the Dexter East Lagoon, Bernie Municipal WWTF, and Vaughn's Gaslight Village treatment facility. The WLAs for these facilities are set at the current permit limits and conditions. The Lemons Landfill West and Tyson Foods, Inc. Dexter Plant are no discharge and storm water discharge facilities, respectively. Loading from these facilities is not anticipated to cause or contribute to the sediment impairment in Lateral #2 Main Ditch. No net reduction in current permit limits is required and WLAs are set at the current permit limits and conditions.

The Lemons Landfill East facility (MO-0113891) discharges to unclassified tributaries of Lateral #2 Main Ditch above the impaired segment. According to discharge monitoring reports, the facility discharges in response to storm events and is not anticipated to discharge during critical low-flow conditions (95 percent flow exceedence). However, during and immediately following storm events the facility has reasonable potential to cause or contribute to the sediment impairment in Lateral #2 Main Ditch. The amount and extent of impact on Lateral #2 Main Ditch depends on the volume of sediment discharged, in-stream assimilative capacity and any settling that may occur on-site or downstream of the facility. At the permitted facility design flow and TSS maximum daily limit, the combined TSS loading from Outfall #001 (1.4 tons/day) and Outfall #2 (3.0 tons/day) is 4.4 tons/day and greater than the 50^{th} percentile flow LC value of 1.64 tons/day. Reductions in TSS

loading are necessary to ensure the load capacity of Lateral #2 Main Ditch is not exceeded during this and other stream flows.

During critical low-flow conditions, it is reasonable to allocate the entire loading capacity of a pollutant as wasteload allocations due to the lack of pollutant contributions from precipitation induced surface water runoff. The loading capacity for TSS during critical low-flow conditions (95 percent flow exceedence) can therefore be allocated among point sources within the Lateral #2 Main Ditch watershed, less a margin of safety to account for uncertainty. A WLA of 0.42 tons/day [0.466 tons/day – 10 percent MOS] will ensure permitted facilities will not cause or contribute to the sediment impairment of Lateral #2 Main Ditch during critical low-flow conditions. To account for point source storm water loading at flow conditions greater than critical low-flow (90 percent flow exceedence and greater), a WLA of 0.50 tons/day will ensure permitted facilities within the watershed do not collectively cause or contribute to the sediment impairment.

The WLAs listed in this TMDL do not preclude the establishment of future point sources of sediment loading in the watershed. Any future point sources should be evaluated in light of the TMDL established and the range of flows into which any additional load will impact.

WLA = (flow in cfs)(concentration in mg/L)(0.0026975 [a conversion factor]) = tons per day

Table 5 – WLAs for Site Specific Permitted Facilities in the Lateral #2 Main Ditch Watershed

Facility	Permit number	WLA (tons per day) d/w/m*
Dexter, East Lagoon	MO-0023213	NA/0.339/0.226 (1.8 MGD)
Bernie Municipal WWTF	MO-0048054	NA/0.066/0.045
Vaughn's Gaslight Village	MO-0048895	NA/0.0015/0.001
Lemons Landfill West	MO-0106895	No discharge
Lemons Landfill East (Outfall 01)	MO-0113891	1.4/NA/1.05
Lemons Landfill East (Outfall 02)	MO-0113891	2.98/NA/2.23
Tyson Foods Inc. Dexter Plant	MO-0129798	Varies (storm water)

*Permit limits based on current design loads where d=daily, w=weekly, m=monthly average.

All other listed facilities (Table 2) have general permits. The WLAs are set at present loads and listings of permit-specific Best Management Practices (BMPs). Additionally, these permits should be reevaluated to determine if general permits are sufficient to protect the impaired segment.

Storm water runoff from all permitted facilities also discharges to the stream. Compliance with the Missouri Storm Water Permit will ensure construction sites meet the TMDL area weighted loadings. The permittee will develop a Storm Water Pollution Prevention Plan (SWPPP). The SWPPP ensures the design, implementation and maintenance of BMPs. EPA assumes that construction activities in the watershed will be conducted in compliance with Missouri's Storm Water Permit including monitoring and discharge limitations. Compliance with this permit should result in sediment loading from construction sites at or below applicable targets.

7. Load Allocation (Nonpoint Source Loads)

LA is the allowable amount of the pollutant that can be assigned to nonpoint sources. The TMDL curve is set at an estimate of expected reference conditions over the range of flows. The LA is set at the remainder for the TMDL loading curve after removing allowances for the point source WLA and MOS (10 percent of the TMDL). For example, at the 50th percentile of flow (median flow) the LC is 1.64 tons per day for this TMDL. Therefore, the LA is 0.98 tons per day and the MOS is 0.16 tons per day.

Table 6. Total Suspended Solids Load Allocations for Lateral #2 Main Ditch

Percent of time flow is exceeded	Flow (cfs)	TMDL (tons/d)	WLA (tons/d)	MOS (tons/d)	LA (tons/d)
95%	5.0	0.46	0.42	0.04	0
90%	6.4	0.59	0.50	0.06	0.03
70%	11.3	1.05	0.50	0.10	0.45
50%	17.6	1.64	0.50	0.16	0.98
30%	28.8	2.68	0.50	0.27	1.91
10%	63.8	6.51	0.50	0.65	5.36
5%	97.2	10.8	0.50	1.10	9.20

8. Margin of Safety

A Margin of Safety (MOS) is usually added to a TMDL, if a TMDL is necessary, to account for the uncertainties inherent in the calculations and data gathering. The MOS is intended to account for such uncertainties in a conservative manner. Based on EPA guidance, the MOS can be achieved through one of two approaches:

(1) Explicit – Reserve a numeric portion of the LC as a separate term in the TMDL.
(2) Implicit – Incorporate the MOS as part of the critical conditions for the WLA and the LA calculations by making conservative assumptions in the analysis.

The MOS for this TMDL is explicit and is set at 10 percent of the TMDL curve.

9. Seasonal Variation

The TMDL curve represents flow under all seasonal conditions. The LA and TMDL (expressed as concentrations) are applicable at all flow conditions, hence all seasons. The advantage of LDC approach is to avoid the constraints associated with using a single-flow critical condition during the development of a TMDL. Therefore, all flow conditions including seasonal variation are taken into account for TMDL calculations.

10. Monitoring Plans

The department has not yet scheduled future monitoring for this water body. However, the department will routinely examine physical habitat, water quality, invertebrate community, and fish community data collected by the Missouri Department of Conservation under its Resource Assessment and Monitoring (RAM) Program. This program randomly samples streams across Missouri on a five to six year rotating schedule.

11. Implementation

The impairment for Lateral #2 Main Ditch is sediment from both point and nonpoint sources. Part of the TMDL will be implemented through permit action. Effluent limits and monitoring requirements for the parameter of interest will be re-evaluated to reflect the water quality targets set by the TMDL as the affected permits come up for renewal. All permitted facilities that are identified to contribute sediment loading to the impaired segment shall adopt appropriate Best Management Practices (BMPs) to reduce such loading from their outfalls. These facilities must also regularly measure in-stream pollutant concentrations to determine the efficacy of the control measures.

General and storm water permits which apply to areas containing TSS/NVSS sources within the Lateral #2 Main Ditch watershed shall be inspected during the implementation phase of this TMDL to determine facility compliance with the terms of the general permit. During the facility inspection, recommendations will be given for implementing and maintaining best management practices that are protective of the impaired stream from future pollutant loading. Should a facility be determined to cause or contribute to an impairment, a site-specific permit can be issued to the facility that contains WLAs for TSS/NVSS that are protective of water quality. Provisions are contained in each general permit that allow the department to revoke the general permit and issue a site-specific permit in its place should more protective permit conditions be required to correct an impairment caused by the facility.

Because the department does not regulate nonpoint sources, the water body will be targeted for development of a watershed group to devise and enact Best Management Practices (BMPs) that will address the impairment. The department recognizes, however, the unique nature of Lateral #2 Main Ditch as a functioning drainage ditch and that dredging may be employed in addition to traditional BMPs to manage sediment in the water body. The most effective BMPs to reduce the frequency and amount of dredging would be related to erosion control, including grassy swales, contour farming, increasing or enhancing the riparian (buffer) zone, off-stream watering of livestock, rotational grazing and more.

12. Public Participation

EPA regulations require that TMDLs be subject to public review (40 CFR 130.7). As stated earlier, this water quality limited segment of Lateral #2 Main Ditch in Stoddard County, Missouri, is included on the EPA approved 1998 and 2002 303(d) lists for Missouri. EPA and the

department's Water Protection Program developed this TMDL. It was placed on public notice from Sept. 18 to Oct. 18, 2008. This is the second public notice for this TMDL, due to changes made in the Load Allocation and Wasteload Allocation. The first public notice period was from March 26 to April 25, 2008. Groups that received the public notice announcement included the Missouri Clean Water Commission, the Missouri Water Quality Coordinating Committee, the affected facilities, 15 Stream Team Volunteers in the county and the four state legislators representing Stoddard County. Also, the department posted the notice, the Sediment TMDL Information Sheet and this document on the department Web site, making them available to anyone with access to the Web. No comments were received.

13. Administrative Record and Supporting Documentation

An administrative record on the Lateral #2 Main Ditch TMDL has been assembled and is being kept on file with the Missouri Department of Natural Resources. It includes any studies and the data and calculations this TMDL is based on.

14. Appendices

Appendix A – Location Map for Lateral #2 Main Ditch
Appendix B – Map of Lateral #2 Main Ditch showing the impaired segment and sampling sites
Appendix C – Development of Suspended Sediment Targets using Reference Load Duration Curves
Appendix D – Ecological Drainage Unit (EDU) Sites used in Flow and TMDL Development
Appendix E – Lateral #2 Main Ditch data

15. References

Kansas Department of Health and Environment (KDHE) (2000). Upper Wakarusa River TMDL (Sediment Impact on Aquatic Life), http://www.kdheks.gov/tmdl/klr/UpWakaTSS.pdf and Little Arkansas River TMDL (Sediment Impact on Aquatic Life), http://www.kdheks.gov/tmdl/la/LittleArkSed.pdf

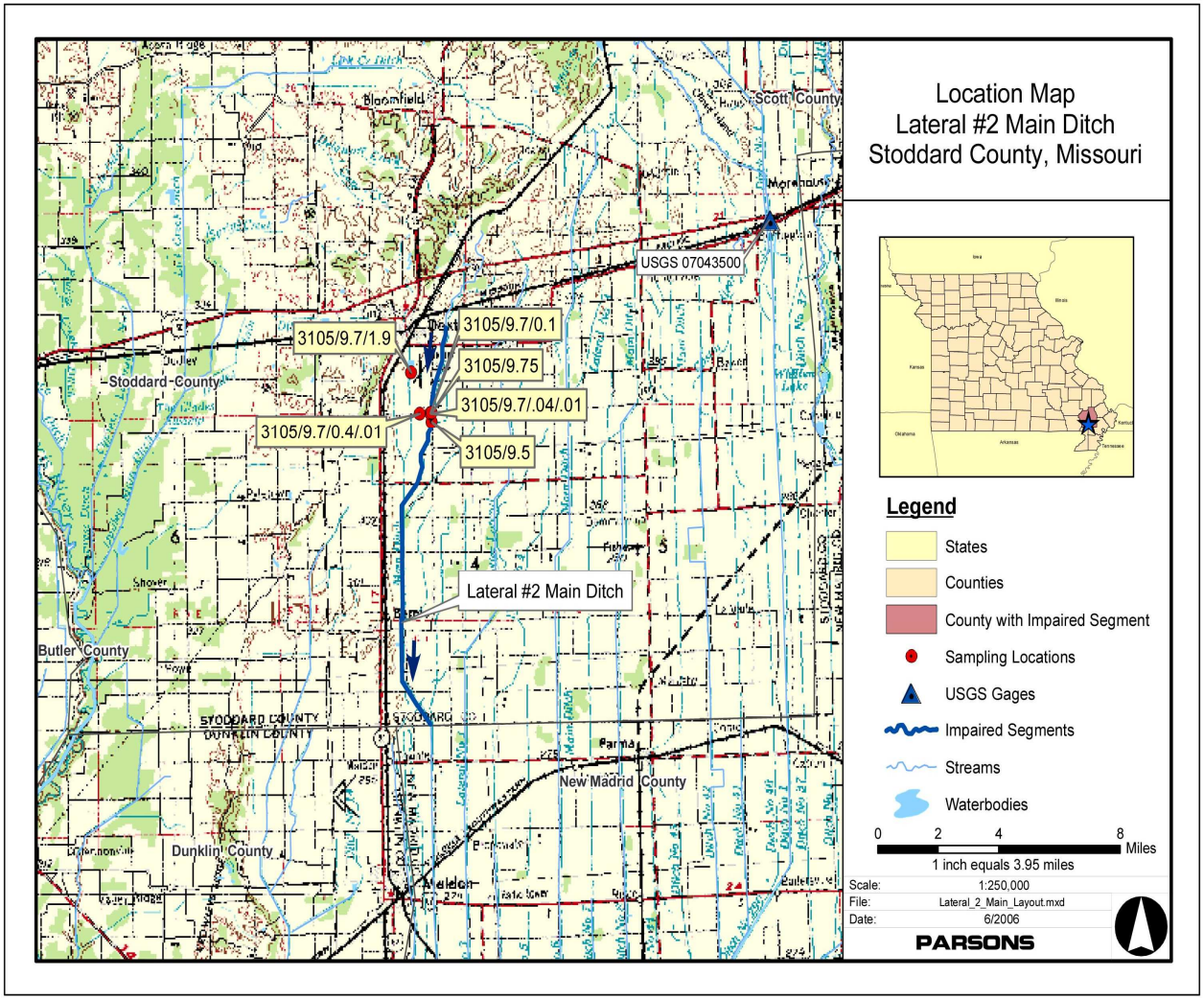
Missouri Department of Natural Resources (MDNR) (2005). Total Maximum Daily Load (TMDL) Information Sheet For Streams with Aquatic Habitat Loss that are Listed for Sediment, http://www.dnr.mo.gov/env/wpp/tmdl/info/habitat-info.pdf

USDA (2002). NASS Quick Stats (Livestock) Census of Agriculture, Volume 1 Chapter 2: Missouri County Level Data http://www.nass.usda.gov/census/census02/volume1/mo/st29_2_001_001.pdf

U.S. Environmental Protection Agency (2006). Framework for Developing Suspended and Bedded Sediments (SABS) Water Quality Criteria, EPA-822-R-06-001.

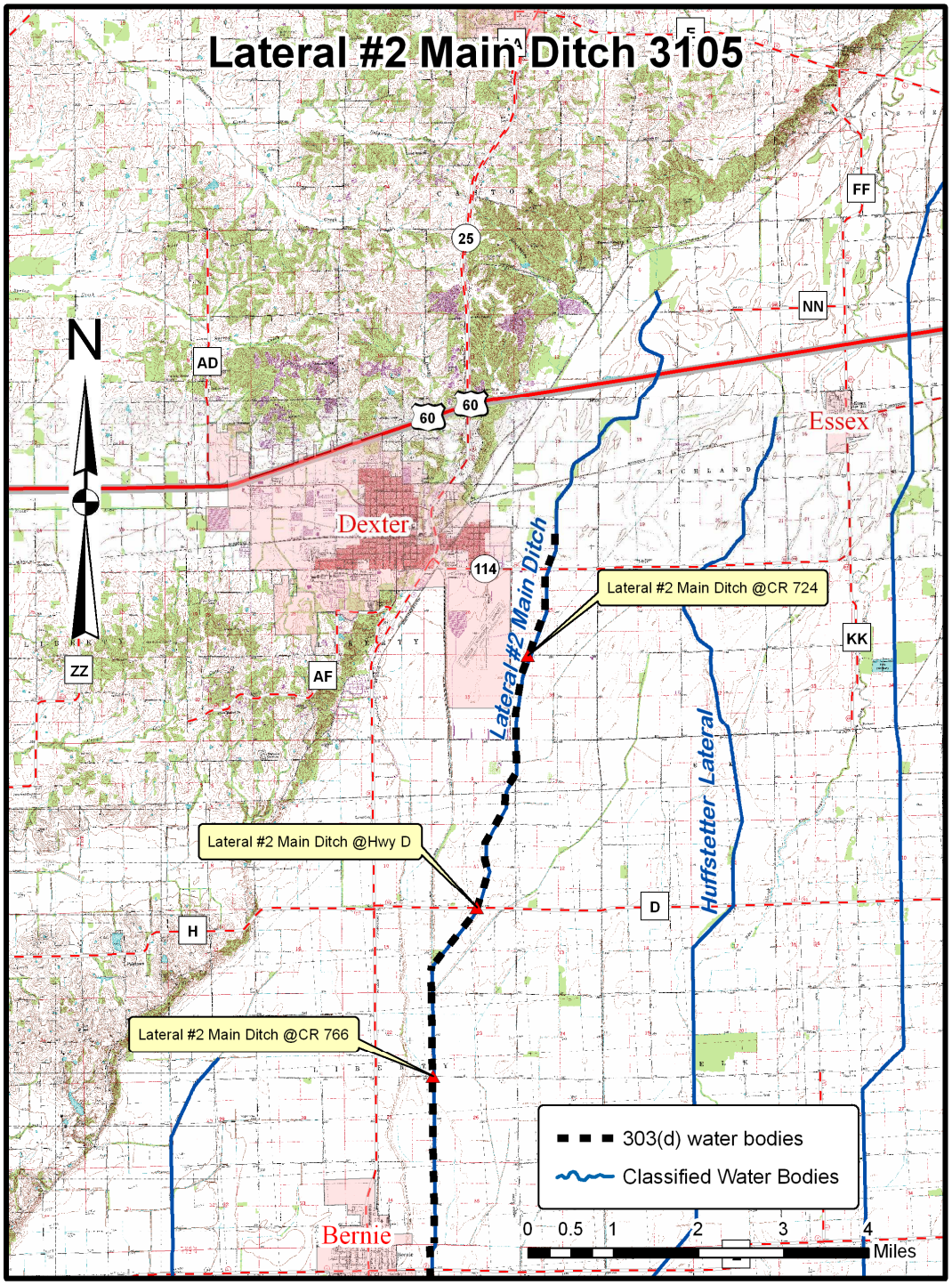
USEPA (2006). Development of Suspended Sediment Targets using Reference Load Duration Curves, EPA Region 7, Kansas City, KS

Appendix A
Location Map for Lateral #2 Main Ditch



Appendix B

Map of Lateral #2 Main Ditch showing the impaired segment and sampling sites



Appendix C

Development of Suspended Sediment Targets using Reference Load Duration Curves

Overview

This procedure is used when a lotic[10] system is placed on the 303(d) List for a pollutant and the designated use being addressed is aquatic life. In cases where pollutant data for the impaired stream is not available a reference approach is used. The target for pollutant loading is the 25th percentile calculated from all data available within the ecological drainage unit (EDU) in which the water body is located. Additionally, it is also unlikely that a flow record for the impaired stream is available. If this is the case, a synthetic flow record is needed. In order to develop a synthetic flow record calculate an average of the log discharge per square mile of USGS gaged rivers for which the drainage area is entirely contained within the EDU. From this synthetic record develop a flow duration from which to build a load duration curve for the pollutant within the EDU.

From this population of load durations follow the reference method used in setting nutrient targets in lakes and reservoirs. In this methodology the average concentration of either the 75th percentile of reference lakes or the 25th percentile of all lakes in the region is targeted in the TMDL. For most cases available pollutant data for reference streams is also not likely to be available. Therefore follow the alternative method and target the 25th percentile of load duration of the available data within the EDU as the TMDL load duration curve.

Methodology

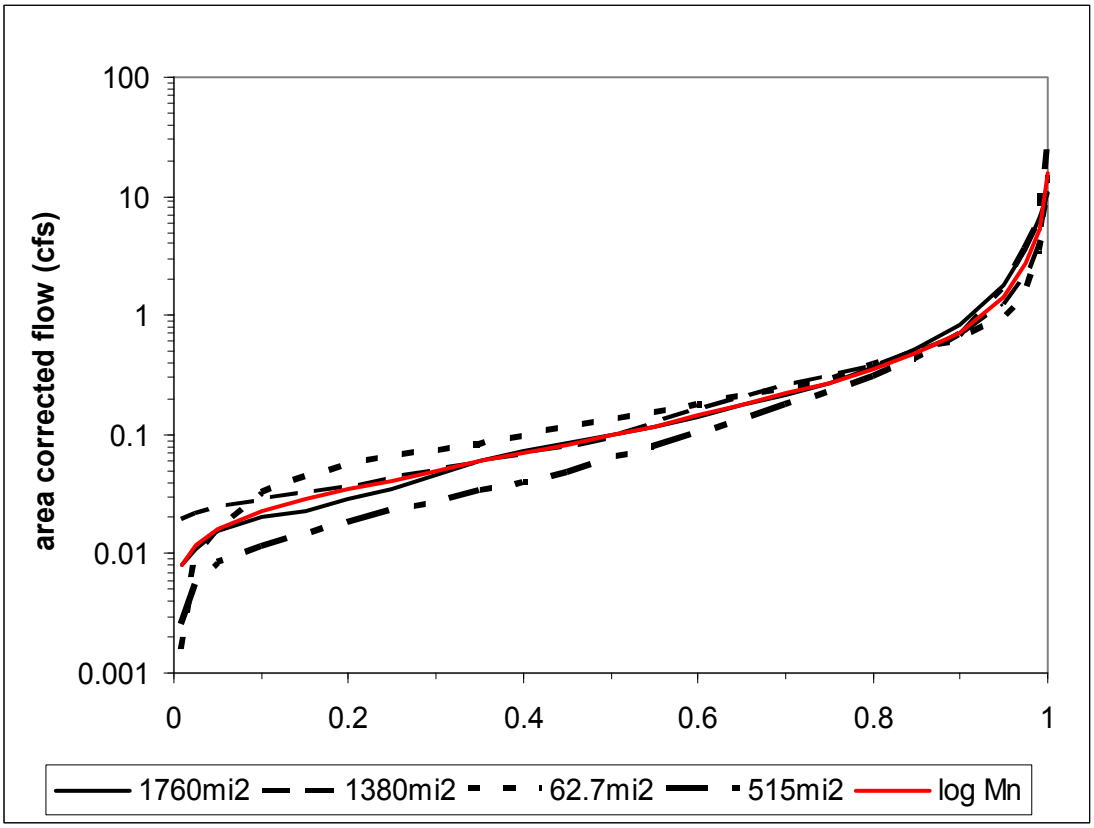
The first step in this procedure is to locate available pollutant data within the EDU of interest. These data along with the instantaneous flow measurement taken at the time of sample collection for the specific date are recorded to create the population from which to develop the load duration. Both the date and pollutant concentration are needed in order to match the measured data to the synthetic EDU flow record.

Secondly, collect average daily flow data for gages with a variety of drainage areas for a period of time to cover the pollutant record. From these flow records normalize the flow to a per square mile basis. Average the log transformations of the average daily discharge for each day in the period of record. For each gage record used to build this synthetic flow record calculate the Nash-Sutcliffe statistic to determine if the relationship is valid for each record. This relationship must be valid in order to use this methodology. This new synthetic record of flow per square mile is used to develop the load duration for the EDU. The flow record should be of sufficient length to be able to calculate percentiles of flow.

[10] Lotic = pertaining to moving water

The following examples show the application of the approach to one Missouri EDU.

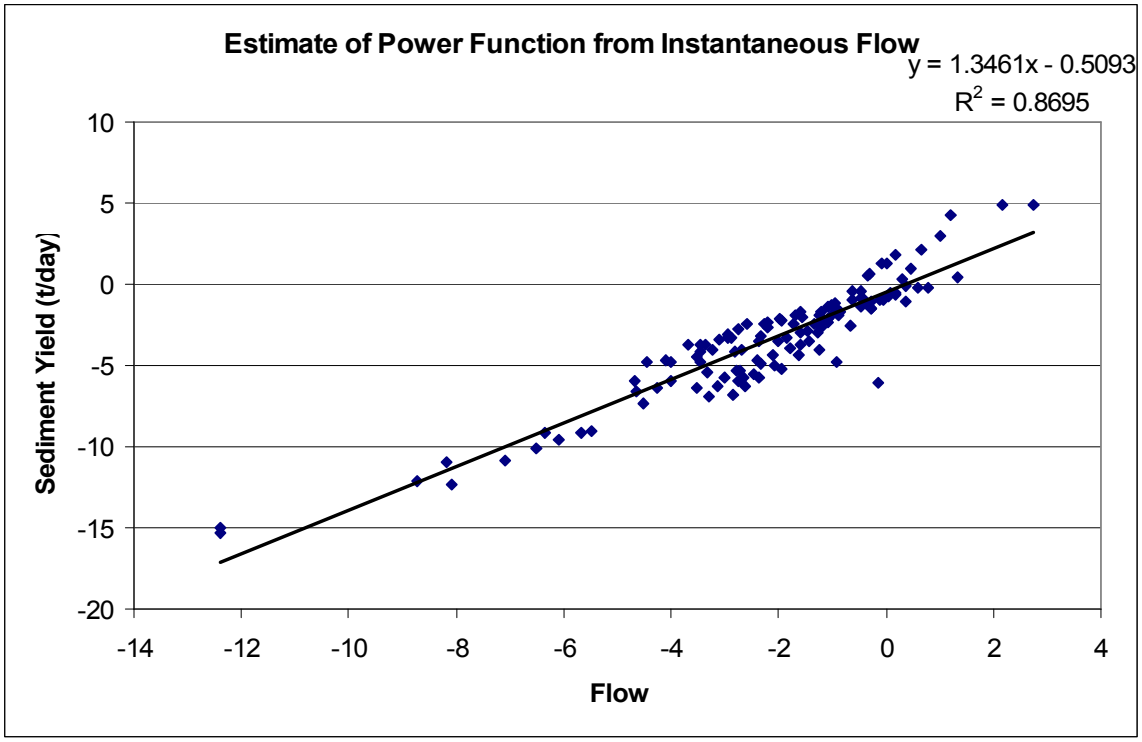
The watershed-size normalized data for the individual gages in the EDU were calculated and compared to a pooled data set including all of the gages. The results of this analyses is displayed in the following figure and table:



Gage	gage	area (mi^2)	normal Nash-Sutcliffe	lognormal Nash-Sutcliffe
Platte River	06820500	1760	80%	99%
Nodaway River	06817700	1380	90%	96%
Squaw Creek	06815575	62.7	86%	95%
102 River	06819500	515	99%	96%

This demonstrates the pooled data set can confidently be used as a surrogate for the EDU analyses.

The next step is to calculate pollutant-discharge relationships for the EDU, these are log transformed data for the yield (tons/mi^2/day) and the instantaneous flow (cfs/mi^2.) The following graph shows the EDU relationship:



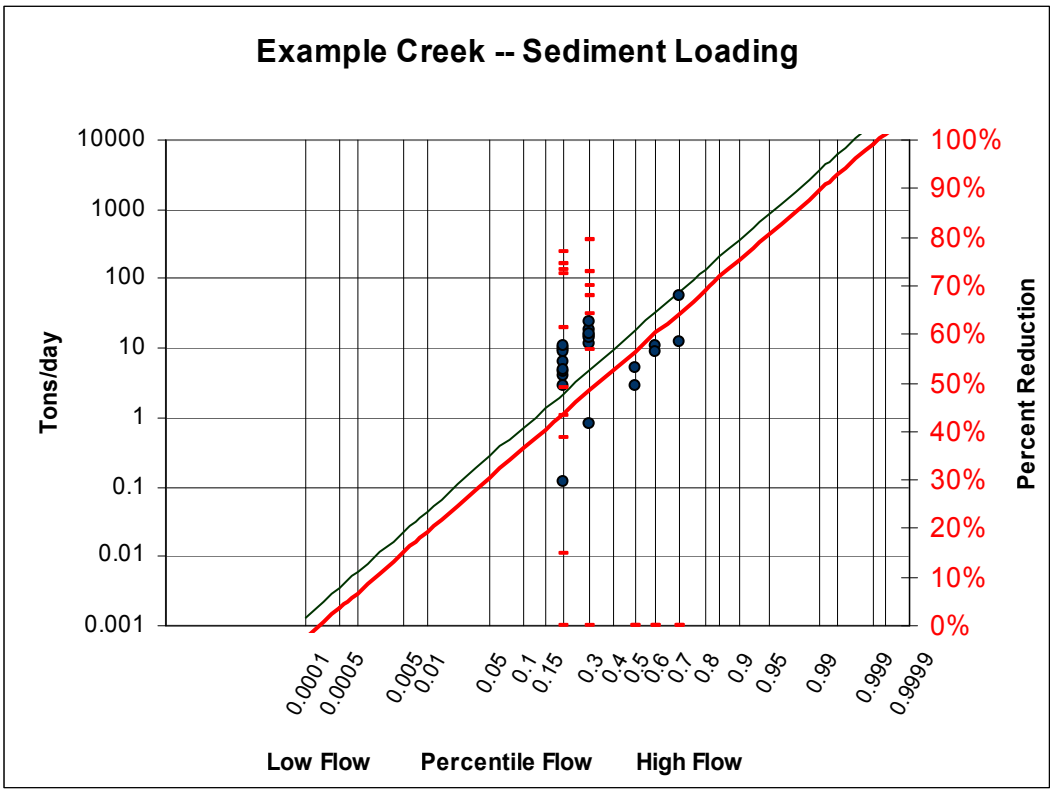
Further statistical analyses on this relationship are included in the following Table:

m	1.34608498	b	-0.509320019
Standard Error (m)	0.04721684	Standard Error (b)	0.152201589
r^2	0.86948229	Standard Error (y)	1.269553159
F	812.739077	DF	122
SSreg	1309.94458	SSres	196.6353573

The standard error of y was used to estimate the 25 percentile level for the TMDL line. This was done by adjusting the intercept (b) by subtracting the product of the one-sided Z_{75} statistic times the standard error of (y). The resulting TMDL Equation is the following:

*Sediment yield (t/day/mi^2) =exp (1.34608498 * ln (flow) - 1.36627)*

A resulting pooled TMDL of all data in the watershed is shown in the following graph:



To apply this process to a specific watershed would entail using the individual watershed data compared to the above TMDL curve that has been multiplied by the watershed area. Data from the impaired segment is then plotted as a load (tons/day) for the y-axis and as the percentile of flow for the EDU on the day the sample was taken for the x-axis.

For more information contact:
Environmental Protection Agency, Region 7
Water, Wetlands, and Pesticides Division
Total Maximum Daily Load Program
901 North 5th Street
Kansas City, Kansas 66101
Website: http://www.epa.gov/region07/water/tmdl.htm

Appendix D
Ecological Drainage Unit (EDU) Sites used in Flow and TMDL Development

USGS stream gages used to generate synthetic flow

Little River Ditch 1 near Kennett, MO	07042000
Little River Ditch 251 near Lilbourn, MO	07042500
Little River Ditch No.1 near Morehouse, MO	07043500
Castor River at Zalma, MO	07021000
Black River at Poplar Bluff, MO	07063000

USGS stream sample sites used to generate EDU TMDL

St Johns Ditch at Henderson's Mound	07042450
St Francis River at Fisk, MO	07040000
Little River Ditch 81 near Kennett, MO	07041000
Little River Ditch 1 near Kennett, MO	07042000
Little River Ditch 251 near Kennett, MO	07044000
Little River Ditch 259 near Kennett, MO	07046000
Little River Ditch near Rives, MO	07046250
Little River Ditch near Kennett, MO	07046001

Appendix E

Lateral #2 Main Ditch data

Site Name	Year	Mo	Day	Time	Flow	C	DO	pH	SC	TSS	TSS Method	TRB
Lateral #2 Main Ditch @CR 724	2007	8	30	1335		29	9	8	526	16	SM2540-D	11
Lateral #2 Main Ditch @CR 724	2007	10	4	1234				7	209	146	SM2540-D	23
Lateral #2 Main Ditch @Hwy D	2007	10	4	1345				9	1120	8	SM2540-D	5
Lateral #2 Main Ditch @Hwy D	2007	8	30	1440		33	14	9	1360	16	SM2540-D	14
Lateral #2 Main @CR 766	2007	8	30	1530		34	11	8	1360	45	SM2540-D	37
Lateral #2 Main @CR 766	2007	5	24	1156	20	24	7.2		441	29	SM 2540-D	23

Note: Flow in cubic feet per second; C=temperature in degrees Celsius; DO=Dissolved Oxygen in mg/L;
SC=Specific Conductivity in microsiemens per centimeter; TRB=turbidity in NTU;
TSS=Total Suspended Solids, NTU=Nephelometric Turbidity Units